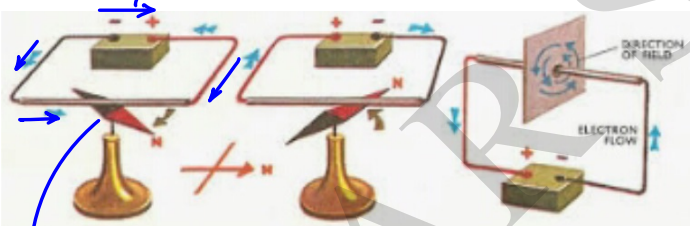
Magnetic Effect of Electric Current

Discovery

- Hans Christian Orsted in 1820

- Heating effect of electric current: James Joule (1840)

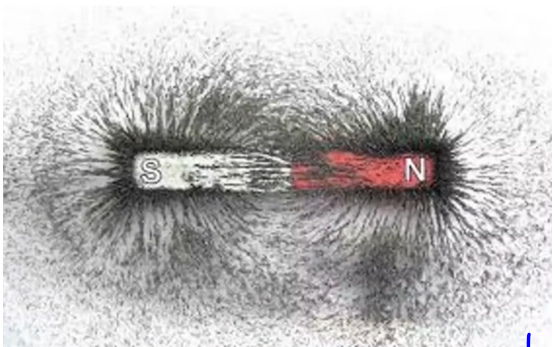
Electric current passed through the wire



Causing deflection in the compass whenever there is a current in wire showing current carrying wire produces a magnetic field around it

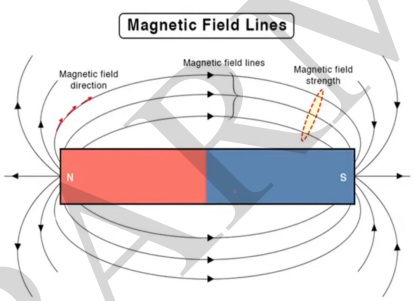
Direction of magnetic field changes due to change in direction of current in the wire

Magnetic Field Lines



- Same poles repel each other
- Different poles attract each other

Iron fillings align themselves with the magnetic field → when spread across a magnetic bar, they respond to magnetic effect of the bar magnet and align themselves accordingly



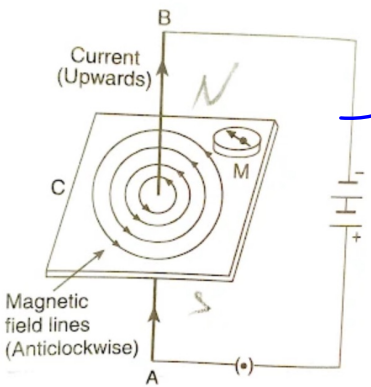
- Magnetic field lines originate from North Pole outside the magnet and terminate at South Pole
- Magnetic field line are in the form of closed loop
- Magnetic field lines never intersect each other

Vector quantity

If they insect, there will be two directions of magnetic field lines which is not possible

- If magnetic field lines are closer → Magnetic Field ↑

Magnetic Field due to a Current Carrying Conductor



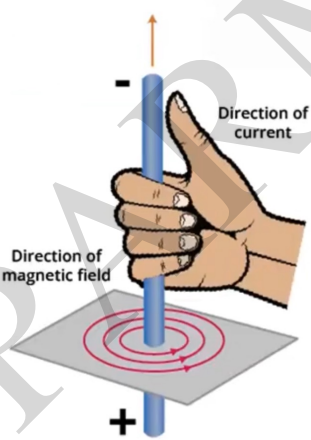
- Magnetic field lines around a straight conductor carrying current are concentric circles whose centre lie on the wire

- Magnetic Field $\propto \frac{1}{\text{Distance}}$

  Distance↑ → Magnetic Field↓

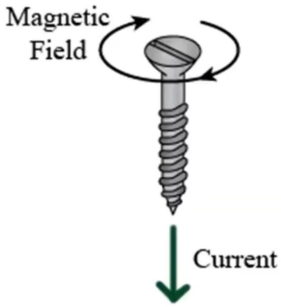
- Current↑ $\propto$ Magnetic Field↑

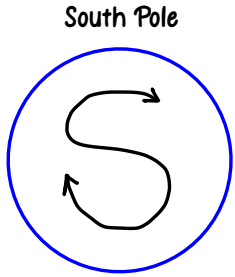
- Direction of current changes → Direction of Magnetic Field changes

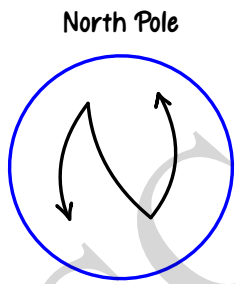


- **Current upwards**: Magnetic field → Anti-clockwise
- **Current downwards**: Magnetic field → Clockwise

Maxwells Right Hand Thumb Rule
to find direction of magnetic field







Maxwell's screw rule to find direction of magnetic field in a straight current carrying conductor

Magnetic Field due to a Current carrying Circular Loop

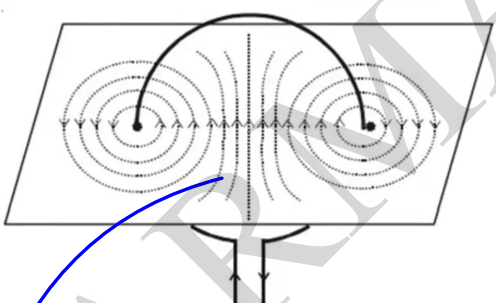
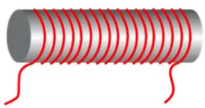


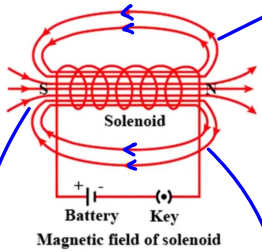
Fig 3.9 Magnetic field due to a circular loop carrying current

In centre, the magnetic field lines are parallel and uniform

- No. of turns in loop ↑ → Magnetic Field ↑
- Distance ↑ → Magnetic Field ↓
- Current ↑ → Magnetic Field ↑

Magnetic Field due to a current carrying Solenoid





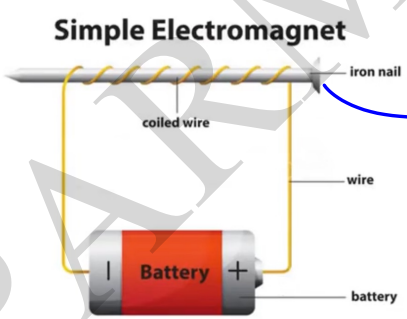
Behaves like a bar magnet when current is passed

- In a solenoid the magnetic field is maximum inside the solenoid
  - It is uniform

- Current passed through a solenoid
- If direction of current is reversed, the direction of magnetic field is also reversed

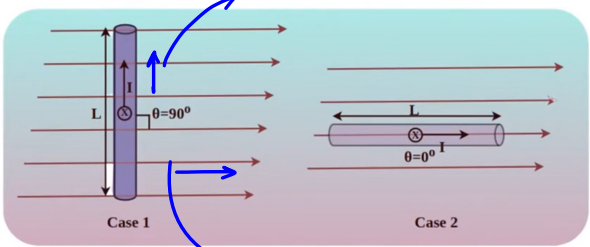
Magnetic field lines outside the solenoid is very weak → Considered to be practically zero

Electromagnetic



Soft iron rod that behaves like a magnet when current is passed through it

Force on a Current Carrying Conductor in a Magnetic Field



Motor works on principle of Fleming's Left Hand Rule

Electric energy → Mechanical energy

. Force will be → **Maximum**: the angle between the conductor and the magnetic field is 90°

Minimum: The conductor is placed along the direction of magnetic field, whether parallel or antiparallel → Zero

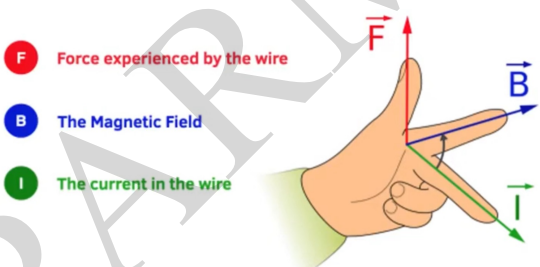
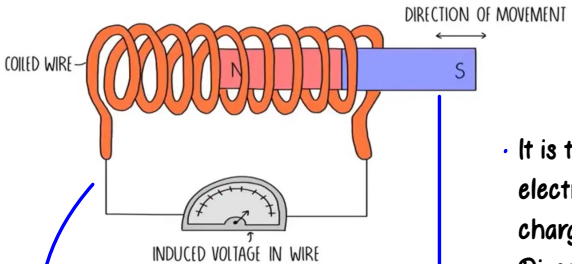


Fig 1. Fleming's Left Hand Rule.

→ Used when a current carrying conductor is introduced in an external magnetic field

Electromagnetic Induction

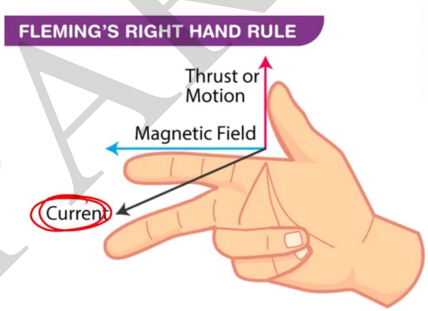
→ Generator work on this concept



- It is the phenomenon in which electric current is generated by charging magnetic fields
- Discovered by Michael Faraday in 1831

When the bar magnet is pushed towards the coil, the pointer in the galvanometer deflects

The relative motion between the magnet and the coil is responsible for generation of electric current in the coil



Generator → Mechanical Energy → Electrical Energy

Short circuit: it is caused due to breaking of insulation of wires, forming the contact between live wire and neutral wire

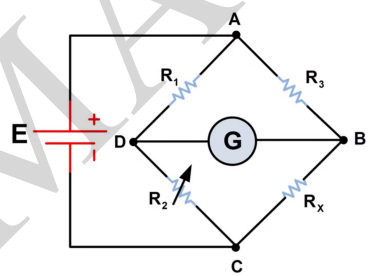
→ Current in a circuit increases abruptly

One Liners (MCQs)

- Device that is used to either break an electric circuit or to complete it: Switch

- Gustav Robert Kirchhoff stated that at a junction in electric circuit, the sum of currents flowing in the junction is equal to the sum of current flowing out of the junction

- Wheatstone Bridge is an arrangement of four resistors used for accurate measurement of resistance



- Coil of wire in an electric room heater is known as: Element

- The current in the bulb will stop flowing if the circuit is broken

- In the symbol of electric cell, the thicker, shorter line represents the: Negative terminal

- Michael Faraday gave the concept of electric field for the first time

- The scientist who was awarded an Noble Prize for the services to Theoretical Physics, and specially for his discovery of Law of Photoelectric Effect: Albert Einstein

$E = h\nu$